1-1-2020

Attentional Bias for Threat and Anxiety: The Role of Loneliness

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Abstract

2020, 2020 Washington School of Psychiatry. Objective: There is literature to suggest that anxious individuals may be lonely. Attentional bias for threat (ABT), a mechanism implicated in the core symptoms of anxiety, has been linked to loneliness in a separate line of work. The primary aim of this study was to examine the role of loneliness in the association between ABT and anxiety. Method: An unselected sample of 260 individuals (196 Female; Mean Age = 22.43) completed measures of loneliness, ABT (a dot probe task), and anxiety. Two possible models of the role of loneliness in the ABT-anxiety link were tested using hierarchical regression analysis: (1) A moderation model (the ABT-anxiety link is moderated by loneliness), and (2) A proxy model (the ABT-anxiety link is better explained by loneliness). Results: In support of the latter model, ABT no longer predicted anxiety after the effects of loneliness had been accounted for. Additionally, ABT was associated with anxiety only when indexed using sadness-related scenes (but not fear-related scenes). Conclusions: Loneliness may be one important source of exaggerated threat appraisals which underpin the association between ABT and anxiety. Different classes of negative stimuli may be differentially sensitive to anxiety and should be a point of consideration in future research.

Disciplines

Education | Social and Behavioral Sciences

Publication Details

Wei, M., Roodenrys, S. & Miller, L. (2020). Attentional Bias for Threat and Anxiety: The Role of Loneliness. Psychiatry (New York),

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Abstract

Objective: There is literature to suggest that anxious individuals may be lonely. Attentional bias for threat (ABT), a mechanism implicated in the core symptoms of anxiety, has been linked to loneliness in a separate line of work. The primary aim of this study was to examine the role of loneliness in the association between ABT and anxiety.

Method: An unselected sample of 260 individuals (196 Female; Mean Age = 22.43) completed measures of loneliness, ABT (a dot probe task), and anxiety. Two possible models of the role of loneliness in the ABT-anxiety link were tested using hierarchical regression analysis: (1) A moderation model (the ABT-anxiety link is moderated by loneliness), and (2) A proxy model (the ABT-anxiety link is better explained by loneliness).

Results: In support of the latter model, ABT no longer predicted anxiety after the effects of loneliness had been accounted for. Additionally, ABT was associated with anxiety only when indexed using sadness-related scenes (but not fear-related scenes).

Conclusions: Loneliness may be one important source of exaggerated threat appraisals which underpin the association between ABT and anxiety. Different classes of negative stimuli may be differentially sensitive to anxiety and should be a point of consideration in future research.

Anxiety-related conditions represent one of the most commonly encountered forms of psychopathology in mental health practice (Douglas & James, 2013). While formal classification systems for mental disorders put forward distinct diagnostic categories for different clusters of anxiety-related symptoms, there also exist core features and hence shared mechanistic underpinnings across the range of formally recognized anxiety-spectrum disorders (Bystritsky et al., 2013; Lang & McTeague, 2009). Attentional bias for threat (ABT), or the tendency to orient more quickly to negative compared to neutral or more positive stimuli (Cisler et al., 2009; Mogg & Bradley, 2016), is thought to favor the encoding of threatening information and represents one mechanism which has been centrally implicated in the core symptoms of anxiety (Bar-Haim et al., 2007; Beck & Clark, 1997; Bradley et al., 1998; MacLeod et al., 1986; Mathews & Mackintosh, 1998; Williams et al., 1988). Research has indicated that traditional psychological interventions (e.g., cognitive-behavioral therapy) for anxiety-related issues produce only modest benefits (Carpenter et al., 2018; Gould et al., 1997). These outcomes have in part been attributed to the implicit nature of ABT, so that the heightened encoding of threatening information occurs on a level of awareness below that required for talking therapies to be effective (Beard, 2011; MacLeod & Mathews, 2012). Yet, contrary to expectations, novel interventions for anxiety which directly target ABT through behavioral training methods have only been partially successful in improving therapeutic outcomes (Mogg & Bradley, 2018; Mogg et al., 2017; Mogoaşe et al., 2014). Collectively, these circumstances point to complexities beyond ABT in the development and maintenance of anxiety, and the need for such complexities to be recognized in research (Heeren & McNally, 2016). Specifically, these circumstances highlight the need for research beyond investigations based on theoretical models of anxiety which account solely for ABT.

Studies on the cognitive and behavioral correlates of anxiety have highlighted several ways in which interpersonal relations may be affected among anxious individuals. For example, chronic worrying about a broad range of topics, a defining feature of anxiety (Hirsch et al., 2013), has been associated with extended decision-making times (Masi et al., 2004), heightened needs for reassurance (Beesdo-Baum et al., 2012), and a tendency to interpret events in the worst possible light (Hayes et al., 2010). These behavioral dispositions can make being in the presence of an anxious individual unpleasant (Newman & Erickson, 2010), and result in the attrition of social networks overtime. Indeed, anxious individuals report having fewer friends than their non-anxious counterparts (Rapee & Melville, 1997; Whisman et al., 2000). There is also evidence to suggest that *subjective experiences* of interpersonal relations may be altered in anxiety. For example, anxious individuals report a sense of being exploitable and helpless in the context of friendships (Eng & Heimberg, 2006), and report lower levels of intimacy in their close relationships compared to non-anxious counterparts (McLeod, 1994).

Loneliness describes a state of being where one's needs for social connectedness are not met (Perlman & Peplau, 1982). Given the evidence to suggest that both quantity and quality of social connections may be compromised in anxiety, it stands to reason that anxious individuals are also more likely to be lonely. To date however, no studies have examined anxiety with a specific focus on loneliness, although anxiety has more broadly been identified as one among the range of mental health conditions where symptom severity is positively associated with loneliness (Richardson et al., 2017; Wang et al., 2018). This paucity in research is particularly surprising considering that lonely individuals also appear to be characterized by habitual patterns of attentional deployment similar to that observed among anxious individuals (Cacioppo et al., 2016, 2009; Shintel et al., 2006). For example, on a modified Stroop task, lonely individuals were slower to name the color of negative words compared to positive words, and compared to their non-lonely counterparts (Shintel et al., 2006). Further, during a simple viewing task, lonely individuals (compared to non-lonely individuals) were characterized by greater brain activity when presented with unpleasant images, and reduced brain activity in response to pleasant images (Cacioppo et al., 2009). These findings suggest that negative information may capture attention more saliently among lonely individuals, consistent with the definition of ABT as the tendency to orient more quickly to negative compared to neutral or more positive stimuli. It is thought that loneliness unwittingly increases one's focus on self-preservation, which in turn entails an enhanced perception of threat in the external world. Among lonely individuals, this enhanced perception of threat is expressed in ABT (Cacioppo & Cacioppo, 2018; Cacioppo & Hawkley, 2009; Spithoven et al., 2017).

The study of loneliness in anxiety has been limited, despite 1) evidence suggesting that anxious individuals are more likely to be lonely and 2) ABT, an assumed core mechanism involved in anxiety, being linked to loneliness in a separate line of work. To date, ABT, loneliness, and anxiety have not been examined within the scope of the same study, which the current research sought to do. Specifically, the current study sought to test two conceptual models of the role of loneliness in the ABT-anxiety link.

First, loneliness may moderate the association between ABT and anxiety. As described above, theoretical accounts of ABT observed among lonely individuals propose that ABT is expressed as a secondary effect of loneliness (Cacioppo & Cacioppo, 2018; Cacioppo & Hawkley, 2009; Spithoven et al., 2017). Thus, ABT is also likely to be more extreme at higher levels of loneliness. By enhancing the magnitude of a qualitatively similar mechanism, it is possible that the presence of loneliness may enhance the effects of ABT on anxiety. Statistically, an association between ABT and anxiety might be more apparent at higher levels of loneliness. If supported, this model could also lend insight to inconsistent findings on the association between ABT and anxiety which have been observed in previous research (e.g., Abend et al., 2018; Fox et al., 2010; Koster et al., 2004; Miloff et al., 2015).

Alternatively, loneliness may play an explanatory role in the association between ABT and anxiety. A proxy model (Kraemer et al., 2001) describes a third variable effect where the relationship between a predictor variable A (ABT) and an outcome variable Y (anxiety) is better explained by a third variable B (loneliness). Proxy models are statistically similar to mediation models, but differentiated on conceptual grounds. While statistical support for both models is inferred when the relationship between A and Y is reduced after accounting for the effects of B on Y, proxy models do not assume causal precedence between variables A and B (i.e. ABT need not causally precede loneliness). The notion that the association between ABT and anxiety may not entirely reflect the direct effects of ABT is first raised when ABT is considered from an evolutionary point of view. From this perspective, being quicker to orient toward threats in the environment should serve an adaptive function in the short-term, rather than result in anxiety over the long-term (Öhman, 2005; Öhman et al., 2001, 2012). Many theories of the ABT-anxiety link recognize this, albeit tacitly, in proposing that anxiogenic effects of ABT are rooted in *exaggerated* appraisals of threat (Bar-Haim et al., 2007; Beck & Clark, 1997; Bradley et al., 1998; Mathews & Mackintosh, 1998; Williams et al., 1988). Given that loneliness enhances subjective perceptions of threat (Cacioppo & Cacioppo, 2018; Cacioppo & Hawkley, 2009; Spithoven et al., 2017), it is possible that loneliness may (at least in part) account for the relationship between ABT and anxiety. As existing literature could theoretically support either of the two models just described, both were examined without an *a priori* hypothesis favoring one model over the other.

METHODS

Participants

Participants were recruited via the research participation scheme at the School of Psychology, University of Wollongong (New South Wales, Australia; *N* = 209), as well as several community forums on the online Platform Reddit which connect researchers and voluntary survey respondents (*N* = 68). Recruitment site (university vs. Reddit) did not alter the pattern of findings as presented in the Results section. All data collection took place remotely via the online platform Psytoolkit (www.psytoolkit.org). A total of 277 participants (196 Female; Mean Age = 22.43, SD = 8.35) completed a behavioral measure of ABT (a dot probe task), and self-report measures of loneliness and anxiety (described below). Participants who did not achieve at least 75% accuracy on the dot probe task (*N* = 17) were removed from further analyses. The final sample constituted 260 participants (183 Female; Mean Age = 22.34, SD = 7.76).

Measures

Attentional Bias for Threat (ABT)

ABT was assessed using a dot probe paradigm. Within a standard dot probe task, each trial begins with a fixation cross (500 ms) followed by the presentation of an emotional-neutral stimulus pair on opposite sides of the screen (500 ms). A probe (i.e. a dot) then quickly replaces either the emotional or neutral stimulus. Emotional-neutral trials are fully counterbalanced with regards to the position of the emotional stimulus (left or right), and whether the probe replaced the emotional or neutral stimulus. Participants are tasked to indicate the location of the probe as quickly as possible via a keyboard press ("E" for left, "I" for right). An attentional bias for the given class of emotional stimuli is typically inferred from the magnitude of the difference score between mean reaction times on incongruent trials (probes replace the emotional stimulus) and mean reaction times on congruent trials (probes replace the neutral stimulus).

The current dot probe task was configured with standard parameters described above, but differs from earlier versions of the task in that it presents stimuli in the form of naturalistic scenes instead of words or isolated faces. Compared to words or isolated faces, naturalistic scenes may provide an advantage in ecological validity in the assessment of ABT (Heitmann et al., 2017; Sagliano et al., 2014; Zvielli et al., 2014). Commonly used scenes to represent threat in the assessment of ABT include scenes which portray loss (e.g., grieving persons) and danger (e.g., person holding an aimed gun). Although typically undifferentiated when implemented in behavioral measures of ABT, the two classes of stimuli relate more closely to the emotions of sadness and fear, and likely differ in the likelihood and immediacy of threat they convey (Kveraga et al., 2015), Given that many theories of the ABT-anxiety link propose that anxiogenic effects of ABT are rooted in exaggerated perceptions of ambiguous threat (Bar-Haim et al., 2007; Beck & Clark, 1997; Bradley et al., 1998; Mathews & Mackintosh, 1998; Williams et al., 1988), it is possible that attentional biases for sadness- and fear-related scenes may not be equally apparent at higher levels of anxiety. Thus, emotional-neutral trials presenting fear-neutral and sad-neutral stimulus pairs were treated as separate experimental conditions, and used to derive separate indices of ABT. The index which returned a stronger correlation with anxiety was used to denote ABT in analyses to address the main aims of the present study (described shortly).

There were 24 fear-neutral and 24 sad-neutral trials in the current dot probe task, as well as 24 happy-neutral and 40 neutral-neutral filler trials which were not presently examined. Trials across the task appeared in complete randomized order for each participant. In anticipation that ABT in loneliness

may be specific to negative stimuli conveying *socially-relevant* information (Cacioppo et al., 2016), indices of ABT were computed based on fear-neutral and sad-neutral trials presenting scenes which featured human persons (12 trials for each condition).The 12 fear-neutral and 12 sad-neutral (social) trials were created using three unique image pairs repeated four times across the experiment. Fear- and sadness-related images (resized to approx. 307 × 230 px) were scenes drawn from the International Affective Pictures System (IAPS) (Lang et al., 2008), and pre-validated for their emotional content in a pilot study (*N* = 103; under review). IAPS identification codes for these images are as follows: Fear – 2770 (tribal member in an aggressive stance), 6250 (man wielding an aimed gun), 6370 (masked man captured on cctv footage); Sad –2141 (woman grieving over deceased man), 2205 (old man at bedside of dying wife), 2900 (boy in tears).[1] Standardized valence ratings (Fear: *M* = 3.30, SD =.92; Sad: *M* = 2.28, SD = .29) and arousal ratings (Fear: *M* = 6.03, SD = .79; Sad: *M* = 4.87, SD = .30) from the IAPS norming study did not differ between the two classes of negative stimuli, $t(4) = 2.35$, $p = .12$ and $t(4) = 1.82$, $p = .19$ respectively.

Loneliness

The UCLA Loneliness Scale (Version 3) (Russell, 1996) was used to measure loneliness. The instrument is composed of 20 items (e.g., “How often do you feel left out?”), where responses vary on a scale ranging from 1 (never) to 4 (always). Nine of the 20 items are positively worded and reverse-scored (e.g., “How often do you feel that there are people you can turn to?”). Possible scores range from 20–80, with higher scores reflecting higher loneliness. Cronbach’s alpha was .93 in the current sample.

Anxiety

The Anxiety subscale of the Depression, Anxiety, and Stress Scales-21 (DASS-21; (Lovibond & Lovibond, 1995a) was used to measure self-reported anxiety. This subscale was developed to capture the range of core symptoms of anxiety (Lovibond & Lovibond, 1995b). Participants completed the full questionnaire so as not to alter the order of presented items. Responses on the DASS-21 have been shown to be temporally stable and suitable for capturing trait-like syndromes (Gomez et al., 2014; Jafari et al., 2017; Lu et al., 2018). On a scale of 0 (did not apply to me) to 3 (applied to me much or most of the time), participants responded to items such as “*I was worried about situations in which I might panic and make a fool of myself*”. Scores on the DASS-21 Anxiety subscale can range from 0 to 21. Cronbach’s alpha for the DASS-21 Anxiety subscale was .87 in the current sample. As an intended control variable to ensure observed findings were generalizable across the severity continuum of anxiety, participants also reported on whether they had been clinically diagnosed with an anxiety disorder (*N* = 69). Although data for

depression severity was available (DASS-21 Depression subscale), we chose not to control for depression severity for several reasons. First, anxious symptoms most commonly precede depression (e.g., Fava et al., 2000; Starr & Davila, 2012), while the current study had interests in anxiety as an outcome variable. Second, given that there is high overlap between depression and loneliness, including depression as a covariate might result in an overadjusted statistical model and underestimation of relevant associations of interest (i.e. the effects of loneliness; Hom et al., 2017).

Data Analyses

Within a dot probe paradigm, attentional bias for a given class of emotional stimuli is typically indexed by subtracting mean reaction times on congruent trials (probe replaces emotional stimulus) from mean reaction times on incongruent trials (probe replaces neutral stimulus) where correct responses are made . This was done separately for fear-neutral and sad-neutral trials to yield two bias scores (Fear and Sad; i.e. two indices of ABT).

The two possible models of the interrelationship between ABT, loneliness, and anxiety were simultaneously tested in a single hierarchical regression analysis predicting DASS-21 Anxiety. Preliminary correlations were performed between study variables to determine the bias score (Fear or Sad) to be used to denote ABT (i.e. the bias score which yielded a higher correlation with DASS-21 Anxiety). Diagnostic history was entered in the first step as a control variable, ABT in the second step, Loneliness in the third step, and the interaction term between ABT and Loneliness in the fourth step.[2] If the association between ABT and anxiety is moderated by loneliness, the interaction term in Step 4 should return statistically significant. If the association between ABT and anxiety is at least in part explained by loneliness (i.e. a proxy model), statistical support would be seen in the reduced effects of ABT moving from step 2 to 3, after accounting for the effects of Loneliness on DASS-21 Anxiety [see Behar et al. (2010), Bujarski et al. (2017), and Spinhoven et al. (2016) for similar approaches].

RESULTS

Table 1 presents the means and correlations between study variables. Mean accuracy rates on the dot probe task were high (*M* = 97.27%, SD = 2.78%). For fear-neutral trials, mean RTs (SDs) used to calculate bias scores are as follows: incongruent – 428.54 (88.43), congruent – 423.67 (83.66). For sad-neutral trials, mean RTs (SDs) used to calculate bias scores are as follows: incongruent – 417.70 (80.62), congruent – 417.37 (79.35).

Table 1. Means and Correlations (*r)* of Study Variables

	1. DASS-21 Anxiety	2. Diagnostic history	3. Sad bias score	4. Fear bias score	5. Loneliness
5	.399**	.172**	-.129*	-.108	-
4	-.046	-.046	.045	-	-
3	-.127*	.056	-	-	-
2	.217**	-	-	-	-
Mean [SD]	3.38 [4.01]	No history (0): *N* = 191 Positive history (1): *N* = 69	0.32 [65.29]	4.87 [83.48]	43.46 [10.39]

*p < .05; **p < .01

Loneliness correlated positively with DASS-21 Anxiety, a finding in keeping with predictions that would be made based on existing literature on how interpersonal relations might be affected among anxious individuals (Beesdo-Baum et al., 2012; Eng & Heimberg, 2006; Hayes et al., 2010; Hirsch et al., 2013; G. Masi et al., 2004; McLeod, 1994; Newman & Erickson, 2010). As seen in Table 1, between the two potential indices of ABT, only the Sad bias score yielded a significant correlation with DASS-21 Anxiety (analyses excluding bias scores ± 3 SD from the mean removed produced the same pattern of findings). Thus, the Sad bias score[3] was used to denote ABT in the subsequent hierarchical regression analysis to predict DASS-21 Anxiety.

Table 2 presents outcomes of the hierarchical regression analysis predicting DASS-21 Anxiety. Results did not support a moderating role of loneliness in the association between ABT and anxiety, in that the interaction term between ABT and Loneliness (Step 4) was not significant, β = − .050, p = .38. However, in support of a proxy account of the relationship between ABT, loneliness, and anxiety, the initial predictive significance of ABT in Step 2 (β = − .139, p = .02) was no longer observed when Loneliness was entered in the model in Step 3 (β = − .089, p = .12 for ABT; β = .360, p = .00 for Loneliness).

Table 2. Hierarchical Regression Analysis Predicting DASS-21 Anxiety

Variable	β	R^2	ΔR^2	F
Step 1		.047	-	12.70**
Diagnostic history	.217 **			
Step 2		.066	.019*	9.11**
Diagnostic history	.224 **			
ABT (Sad bias score)	-.139*			
Step 3		.189	.123**	19.95**
Diagnostic history	.160*			
ABT (Sad bias score)	-.089			
Loneliness	.360**			
Step 4		.192	.002	15.14**
Diagnostic history	.158*			

ABT (Sad bias score)	-.082			
Loneliness	.362**			
ABT (Sad bias score) x Loneliness	-.050			

***β* =** Standardised coefficients
*$p < .05$; **$p < .01$

DISCUSSION

Extant literature on the quantity and quality of social connections in anxiety has given reason to suggest that loneliness may be more likely to occur among anxious individuals (Beesdo-Baum et al., 2012; Eng & Heimberg, 2006; Hayes et al., 2010; Hirsch et al., 2013; Masi et al., 2004; McLeod, 1994; Newman & Erickson, 2010). ABT, an assumed core mechanism involved in anxiety, has been linked to loneliness in a separate line of work (Cacioppo et al., 2016, 2009; Cacioppo & Cacioppo, 2018; Cacioppo & Hawkley, 2009; Shintel et al., 2006; Spithoven et al., 2017). As part of a movement in research acknowledging complexities beyond ABT in the development and maintenance of anxiety, the current study examined two possible models of the ABT-anxiety link inclusive of a third variable, namely loneliness. The first model examined whether loneliness would moderate/strengthen the association between ABT and anxiety. The second (proxy) model examined whether loneliness might (at least in part) account for the association between ABT and anxiety. Present findings favor the latter conceptualization of the role of loneliness in the ABT-anxiety link. That is, the strength of the association between ABT and anxiety did not vary as a function of loneliness. However, loneliness did make a unique contribution to predicting anxiety, and ABT no longer uniquely predicted anxiety after the effects of loneliness were accounted for.

The rationale for investigating the proxy model was that, from an evolutionary viewpoint, faster orientation to threats in the environment should serve an adaptive function in the short-term rather than result in anxiety over the long term (Öhman, 2005; Öhman et al., 2001, 2012). The finding that ABT was no longer associated with anxiety in the presence of a third variable *per se* suggests that ABT may not inherently produce anxiogenic effects, and is in keeping with this notion. Additional support for the normative aspects of ABT comes from the presently observed selective association between indices of ABT and anxiety. ABT was associated with anxiety only where defined by patterns of attentional deployment for sadness-related scenes, but not fear-related scenes. Fear-related scenes, including those presently employed, typically feature situations which arguably convey information about actual, unambiguous sources of danger (e.g., person wielding an aimed gun).

Heightened attentional responding to such information may represent an adaptive process which occurs independently of anxiety. Conversely, sadness-related scenes typically feature situations where harm has ostensibly passed (e.g., grieving persons). Heightened attentional responding to such information may favor the encoding of threat which may not be immediately or personally relevant, setting the individual up to experience the world as an inherently unsafe place [i.e. a key feature of anxiety; Hazlett-Stevens (2008)]. While further research is necessary to verify these speculations, present observations serve to echo previous sentiments on the importance of drawing qualitative distinctions in negatively-valenced material used to assess ABT in anxiety (Calvo & Avero, 2005; Calvo & Lang, 2004).

In tacit acknowledgment that ABT is fundamentally adaptive, many theories of the ABT-anxiety link propose that anxiogenic effects of ABT are rooted in exaggerated appraisals of threat (Bar-Haim et al., 2007; Beck & Clark, 1997; Bradley et al., 1998; Mathews & Mackintosh, 1998; Williams et al., 1988). Relatedly, ABT documented among lonely individuals is thought to be a function of enhanced threat perception in loneliness (Cacioppo & Cacioppo, 2018; Cacioppo & Hawkley, 2009; Spithoven et al., 2017). It was presently observed that ABT no longer uniquely predicted anxiety in the presence of loneliness, supporting a proxy model of the interrelationship between loneliness, ABT and anxiety in which the association between ABT and anxiety is better explained by loneliness. These results (along with the earlier described finding on the selective association between indices of ABT and anxiety) are consistent with the notion that the anxiogenic effects of ABT are rooted in exaggerated appraisals of threat. Further, the current results suggest that loneliness may be one important source of exaggerated threat appraisals which underpin the association between ABT and anxiety. These findings serve to reiterate the need for more complex models of anxiety beyond ABT (Heeren & McNally, 2016), and add a voice to the growing movement away from investigating ABT as an isolated process in anxiety-related research.

The present findings hold implications for clinical practice. The limited efficacy of both traditional (i.e. cognitive-behavioral therapy) and novel interventions for anxiety (i.e. behavioral training to reduce ABT) highlight the need to extend the range of therapeutic methods which can be implemented to effectively manage anxiety. Present [and previous: (Richardson et al., 2017; Wang et al., 2018)] findings suggest that loneliness may contribute to anxiety, so that anxious individuals may also stand to benefit from interventions which seek to reduce loneliness (and thus enhanced perceptions of threat). It should be noted, however, that although present findings favor the clinical utility of reducing loneliness over ABT where anxiety is concerned, several caveats have been highlighted pertaining to interventions for loneliness. Efforts to reduce loneliness often involve the training of social skills and provision of opportunities to develop social relationships (Cacioppo et al., 2015; Masi et al., 2011; Ypsilanti, 2018). Such interventions may help expand the social

network of an individual, but do not necessarily alleviate subjective feelings of social isolation (Cacioppo et al., 2015; Masi et al., 2011; Ypsilanti, 2018). Although reductive effects on anxiety may be modest (Mogg & Bradley, 2018; Mogg et al., 2017; Mogoaşe et al., 2014), studies and clinical trials which have sought to modify ABT via behavioral training methods have indicated that ABT is at least amendable to change [see (Mogg et al. (2017) and Mogoaşe et al. (2014) for reviews]. Where challenges to reducing loneliness prevail, reducing ABT may still retain its clinical utility as the comparative next-best option in interventions to target enhanced threat perceptions associated with anxiety.

Current findings should be interpreted in light of several constraints. First, to account for the specificity of ABT in loneliness (Cacioppo et al., 2016), ABT was indexed based on social stimuli (i.e. scenes which featured human persons). Although ABT based solely on social stimuli (e.g., faces) has been documented among anxious individuals (Bar-Haim et al., 2007), heightened attentional orienting in anxiety appears to extend to nonsocial pictorial stimuli which convey threat (e.g., scenes portraying snakes, natural disasters, injured animals) (Sagliano et al., 2014; Zvielli et al., 2014). While present findings suggest loneliness may play an explanatory role in the association between ABT and anxiety, it is unclear if the explanatory value of loneliness holds for the association between attentional bias for nonsocial threat and anxiety.[4] Second, the direction of influence from loneliness to anxiety was assumed based on self-report measures at a single timepoint in the present cross-sectional study, even though a bidirectional relationship between the two variables is possible. Previous studies have shown that loneliness can be experimentally manipulated under laboratory settings through the use of social exclusion paradigms [e.g., Hames et al. (2018) and Stillman et al. (2009)], and should be considered in future research. Third, the presently observed correlation between Sad bias score (used to index ABT) and self-reported anxiety was small ($r = -.127$). Although previous studies have found associations between indices of ABT and anxiety of similar magnitude (Abend et al., 2018; Campbell & Kertz, 2019; Ho et al., 2017), it remains possible that this may have influenced the current main findings (i.e. ABT no longer predicted anxiety in the presence of loneliness). Last, while the convenience sampling method used in the present study yielded a participant pool with adequate variability in self-reported anxiety, mean anxiety levels were low (Mean DASS-21 Anxiety = 3.38, SD = 4.01). Although current findings on the role of loneliness in the ABT-anxiety link were observed after accounting for diagnostic history (i.e. presence/absence of a clinically diagnosed anxiety disorder), further research is necessary to verify that these findings also apply to individuals experiencing more severe anxiety.

Disclosure statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Data Availability

Research data for this manuscript can be accessed at: https://osf.io/u8hmf

Notes

1. These images were paired with neutral images matched for social content. Four of these images were drawn from the IAPS and have the following identifier codes: 7550, 2440, 2575, 2745.1. Two neutral images were sourced from free online stock photo databases and are available upon request. All pictures used were assigned a common emotional label by > 75% of viewers (N = 103).

2. Mean-centered Sad bias and Loneliness scores were entered in the analysis and used to calculate the interaction term. For hierarchical regression analyses with 4 predictors, the minimum sample size is 39 based on anticipated f^2 of 0.35 and desired power of 0.8 (p =.05). The current sample size met this criterion.

3. Of note, the relationships between the Sad bias score and both DASS-21 Anxiety and UCLA Loneliness were inverse in nature. When stimuli are presented at durations which allow for conscious perception (> 200 ms) such as in the current dot probe task, this allows sufficient time for gaze aversion following initial attentional capture by the emotional stimulus (Barry et al., 2015; Booth, 2014). While this manifests in overall faster motor responses to probes replacing neutral scenes (i.e. decreasing bias scores), such a pattern of behavioral responding also entails that the initial orientation of attention toward the negative stimulus was speeded (Barry et al., 2015; Booth, 2014). Thus, current results do not necessarily contradict the notion that higher levels of anxiety and loneliness are associated with the tendency to orient more quickly to negative compared to neutral cues.

4. In supplementary analyses using available data from nonsocial trials, presently reported findings on the association between loneliness, ABT, and anxiety were not replicated.

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Additional information

Funding

This work was supported by the University of Wollongong [Maryann Wei is kindly supported in her PhD candidature by scholarships awarded by the University of Wollongong].